

Subject: Re: Why did our surveys not discover 2019 OK
Date: Friday, July 26, 2019 at 11:28:40 AM Pacific Daylight Time
From: Johnson, Lindley (HQ-DG000)
To: Chodas, Paul W (US 4085)

OK, sounds fine.

Just the facts as we know them.

Lindley

Lindley N Johnson
Planetary Defense Officer
HQ NASA

----- Original Message -----

From: "Chodas, Paul W (US 4085)" <paul.w.chodas@jpl.nasa.gov>
Date: Fri, July 26, 2019 2:22 PM -0400
To: "Johnson, Lindley (HQ-DG000)" <lindley.johnson@nasa.gov>
Subject: Re: Why did our surveys not discover 2019 OK

DC gave me the OK (!), so I'll call them now. They're on a short fuse...

Paul

From: "Johnson, Lindley (HQ-DG000)" <lindley.johnson@nasa.gov>
Date: Friday, July 26, 2019 at 11:20 AM
To: "Chodas, Paul W (US 4085)" <paul.w.chodas@jpl.nasa.gov>
Subject: Re: Why did our surveys not discover 2019 OK

They have requested an interview which I have forwarded to OCOMMS for response but have not gotten the Ok yet.

Lindley

Lindley N Johnson
Planetary Defense Officer
HQ NASA

----- Original Message -----

From: "Chodas, Paul W (US 4085)" <paul.w.chodas@jpl.nasa.gov>
Date: Fri, July 26, 2019 2:09 PM -0400
To: "Johnson, Lindley (HQ-DG000)" <lindley.johnson@nasa.gov>
Subject: Re: Why did our surveys not discover 2019 OK

Thanks for forwarding this, Lindley. This is an interesting question, and we should view it as a learning

opportunity.

But I think it is fair to say that 2019 OK snuck past our usual observation checkpoints that catch most such incoming NEAs.

NPR's All Things Considered inquired about this asteroid. Shall I respond? Have you already talked to them?

Paul

Dr. Paul W. Chodas
Manager, Center for Near Earth Object Studies
Jet Propulsion Laboratory

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(b)(6)

From: "Johnson, Lindley (HQ-DG000)" <lindley.johnson@nasa.gov>
Date: Friday, July 26, 2019 at 10:59 AM
To: "Chodas, Paul W (US 4085)" <paul.w.chodas@jpl.nasa.gov>
Subject: Fwd: Why did our surveys not discover 2019 OK

Been having the same conversation back here.

Lindley

Lindley N Johnson
Planetary Defense Officer
HQ NASA

----- Original Message -----

From: (b)(6)
Date: Fri, July 26, 2019 8:19 AM -0400
To: "Johnson, Lindley (HQ-DG000)" <lindley.johnson@nasa.gov>
CC: "Fast, Kelly E. (HQ-DG000)" <kelly.e.fast@nasa.gov>, (b)(6)
Subject: Re: [EXTERNAL] Pan-STARRS comments: Lindley wins the prize

Hi Lindley, all... I will DEFINITELY endorse that there is too much attention paid (blown??) on small objects. There is an infinite loop here and it is a hard one to deal with. We have to keep an eye on possible small impactors, but the only small objects we see are close, so we have to track most of them.

That being said, I am pretty sure Davide (who I think can solve all celestial mechanics problems in a single bound) could come up with an algorithm that tells you what the chances are your object of (insert size) could impact the Earth on this apparition. I suspect we could literally clear the NEOCP every five minutes of most of the chaff this way. Maybe we do something like--what's the moid, what's the size of the object, what's the chance of impacting this time around? We could clear out the non-PHAs very easily, and focus only on the objects that need immediate follow-up, and those with small moids but are large enough to be of interest.

We would need to guide the surveys a bit on where to survey for the largest and most interesting objects. I think that means repeated coverage of opposition at least for groundbased optical.

I've turned this question inside out and it kinda flummoxes the survey folks--how many 50 meter objects do you have to follow-up before you find an actual impactor? I think it is hundreds of thousands. So this means that if you see a 50-meter object with no chance of impact this time around you should drop it immediately because you're actually damaging your ability to detect the important one. That's probably a little cheeky and cheating with statistics... but some of it rings true.

(b)(6)

On Fri, Jul 26, 2019 at 8:09 AM Johnson, Lindley (HQ-DG000) <lindley.johnson@nasa.gov> wrote:

Not really instinct. I just looked at the obs submitted on the MPEC.

But what im really wondering is that in an effort to build up their discovery counts, i.e. go for smaller and therefore usually faster moving objects, the surveys are leaving open a corner of the larger objects, albeit while still faint and slow moving.

Lindley

Lindley N Johnson
Planetary Defense Officer
HQ NASA

----- Original Message -----

From: "Fast, Kelly E. (HQ-DG000)" <kelly.e.fast@nasa.gov>

Date: Fri, July 26, 2019 7:54 AM -0400

To: (b)(6) "Johnson, Lindley (HQ-DG000)" <lindley.johnson@nasa.gov>, (b)(6)

Subject: Re: [EXTERNAL] Pan-STARRS comments: Lindley wins the prize

Wow, not the answer I what I was expecting, but I don't have Lindley's instincts! Thanks so much, Tim, this is really fascinating. And a tough issue since I'm guessing it must be difficult to go after slow objects and not pick up more false detections and to also disentangle them from TNOs.

Dr. Kelly Elizabeth Fast
Near-Earth Object Observations Program Manager
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From: (b)(6)

Date: Thursday, July 25, 2019 at 9:13 PM

To: Lindley Johnson <lindley.johnson@nasa.gov>, Kelly Fast <kelly.e.fast@nasa.gov>, (b)(6)

(b)(6)

Subject: [EXTERNAL] Pan-STARRS comments: Lindley wins the prize

Hi all, I got comments back from (b)(6) Pan-Starrs missed 2019 OK because it was too faint in June, and too slow in July. It was actually in the clear in the frames in each month (all 4 frames) so it theoretically could have been detected.

I must compliment Lindley on his instincts here. There is a spectacularly important lesson here--ATLAS and to a lesser extent Pan-STARRS need to detect slower objects. The raison d'etre for ATLAS is detecting imminent impactors. It looks like some impactors are too slow to be found easily. It is fairly disturbing to me that this object was undetectably slow for nearly 2 weeks! Fascinating stuff.

So the executive summary: the object was missed because it was too faint in June, and too slow to detect in July until right before the close approach.

Hope this helps--if you need anything else let me know!

(b)(6)

Subject: Re: [EXTERNAL] Re: Unhappy about Washington Post story
Date: Saturday, July 27, 2019 at 2:24:42 PM Pacific Daylight Time
From: Johnson, Lindley (HQ-DG000)
To: EXTERNAL-Fast, Kelly (US 9300-NASA), EXTERNAL- [REDACTED] (b)(6)
CC: [REDACTED] (b)(6) (HQ-DG000)[NATIONAL INSTITUTE OF AEROSPACE], Chodas, Paul W (US 4085), Johnson, Alana R. (HQ-NG000)[InuTeq, LLC]

Guess I missed news of the meteor that this one was about, if only a couple days ago.

Yes, i really would like OCOMMS to do a full court press with the national networks about who to talk to if there is a significant bolide or close approach story. Obviously, them just grabbing whomever is at there local university or natural history museum, even if it is NYC, just doesnt get an accurate story out. I've been recommending this to OCOMMS for years and JoAnna was starting to push on it, but they've been reluctant to make contacts unless there is a story - but when there is then a story it is too late because the media just grabs the first person they can find.

Lindley

Lindley N Johnson
Planetary Defense Officer
HQ NASA

----- Original Message -----

From: "Fast, Kelly E. (HQ-DG000)" <kelly.e.fast@nasa.gov>
Date: Sat, July 27, 2019 2:28 PM -0400
To: [REDACTED] (b)(6)
CC: "Johnson, Lindley (HQ-DG000)" <lindley.johnson@nasa.gov>, [REDACTED] (b)(6) (HQ-DG000)[NATIONAL INSTITUTE OF AEROSPACE] [REDACTED] (b)(6) "Chodas, Paul W (JPL-4085)[Jet Propulsion Laboratory]" <paul.w.chodas@jpl.nasa.gov>, "Johnson, Alana R. (HQ-NG000)[InuTeq, LLC]" <alana.r.johnson@nasa.gov>
Subject: Re: [EXTERNAL] Re: Unhappy about Washington Post story

Well, here's someone from the American Museum of Natural History yesterday who even knows about the Congressional direction, but he uses the royal "we," he doesn't say the direction was given to NASA, and he concludes that we don't know what to do if we do find one (no knowledge of DART or NASA work, or the U.S. Nat'l NEO Strategy and Action Plan). Can skip to 4:00:

<https://newyork.cbslocal.com/video/4132510-east-coast-fireball-explained/>

Although one problem is that the press doesn't ask NASA, it seems that a bigger problem is that the scientists the press consults don't know or communicate properly about NEOs and PD and they don't recognize their own shortcomings or refer to NASA where appropriate. Our journalist workshops help, but I think we need to fire Lindley and post his job to make national news (hey, it worked for planetary protection) and then he can do the morning show and talk show circuit once he is rehired! Seriously, we need a PD road show...

Dr. Kelly Elizabeth Fast
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From: [REDACTED] (b)(6)
Date: Saturday, July 27, 2019 at 1:44 PM
To: Kelly Fast <kelly.e.fast@nasa.gov>
Cc: Lindley Johnson <lindley.johnson@nasa.gov>, [REDACTED] (b)(6) (HQ-DG000)[NATIONAL INSTITUTE OF AEROSPACE]" [REDACTED] (b)(6) "Chodas, Paul W (JPL-4085)[Jet Propulsion Laboratory]" <paul.w.chodas@jpl.nasa.gov>, "Johnson, Alana R. (HQ-NG000)[InuTeq, LLC]" <alana.r.johnson@nasa.gov>
Subject: Re: [EXTERNAL] Re: Unhappy about Washington Post story

Hi Kelly, not dragging out. This one is necessary IMO.

The ASASSN guys have a long history with the MPC. Gareth and I had to chew them out (in an MPEC no less) in their previous iteration for announcing--via the Astronomer's Telegram--an object for which they predicted a chelyabinsk-type impact. They were wrong. Their astrometry was really bad and when confirmed the object was .2 AU away or something. So it is no surprise they ignored NASA and the MPC. At least not to me.

The full details on this object are scant. I can't tell who actually found it--I think I'll have to go to Gareth. The discovery is currently SONEAR, who is applying for IAWN membership. But ASASSN folks apparently used two scopes at existing big telescope locations in the US but didn't use the right observatory codes. Ugh.

I know one of the goals of IAWN is to be the source for information. How do we do that when the press interviews random astronomer--or worse, Voldemort (let's not forget he was interviewed about NEOs on CNN...)?

(b)(6)

On Sat, Jul 27, 2019 at 1:06 PM Fast, Kelly E. (HQ-DG000) <kelly.e.fast@nasa.gov> wrote:

So here's Popular Science, also not asking NASA or CNEOS, rattling off numbers without sources (and quotes from Boslough and OSU's Stanek are from other interviews):

<https://www.popsci.com/asteroid-close-earth-ok-2019/>

Sorry to drag out the conversation, but as I wonder why the media talk to the first person they find instead of NASA...

They do quote Kris Stanek at OSU who spoke with Public Radio International and who observed 2019 OK with the All-Sky Automated Survey for Supernovae (ASASSN). I don't see that ASASSN submitted 2019 OK observations to MPC, or even has an observatory code. Looking at their page <http://www.astronomy.ohio-state.edu/~assassin/index.shtml>

their telescopes are hosted on LCO sites, but LCO isn't listed as observing 2019 OK either. Tim, does

ASASSN submit to MPC and I missed it? They fancy themselves a "Small Synoptic Survey Telescope" complementing LSST by surveying shallow and often, sort of a supernova version of ATLAS, but they survey only to 18th magnitude (with quads of 14cm telescopes).

But if they're speaking on the radio about observing NEOs with their survey, they should either get more background or refer to NASA. At least the OSU person did say that \$1B/yr should go to NEO work, ha! I gave a PD talk at OSU a few years ago when Kirsten was a chemistry undergrad there, but it was in the School of Earth Sciences, not the Astronomy Dept.

Kelly

Dr. Kelly Elizabeth Fast
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From: (b)(6)
Date: Saturday, July 27, 2019 at 10:26 AM
To: Lindley Johnson <lindley.johnson@nasa.gov>
Cc: (b)(6) (HQ-DG000)[NATIONAL INSTITUTE OF AEROSPACE] (b)(6)
Kelly Fast <kelly.e.fast@nasa.gov>, "Chodas, Paul W (JPL-4085)[Jet Propulsion Laboratory]" <paul.w.chodas@jpl.nasa.gov>, "Johnson, Alana R. (HQ-NG000)[InuTeq, LLC]" <alana.r.johnson@nasa.gov>
Subject: Re: [EXTERNAL] Re: Unhappy about Washington Post story

AMEN to that... let's not forget they have periodically had good advocates and even programs, and shut them down...

(b)(6)

On Sat, Jul 27, 2019 at 10:11 AM Johnson, Lindley (HQ-DG000) <lindley.johnson@nasa.gov> wrote:

What makes this especially galling is that the Australian are doing essentially nothing to support Planetary Defense.

Lindley

Lindley N Johnson
Planetary Defense Officer
HQ NASA

----- Original Message -----

From: (b)(6)
Date: Sat, July 27, 2019 9:55 AM -0400

To: "Johnson, Lindley (HQ-DG000)" <lindley.johnson@nasa.gov>
CC: "Fast, Kelly E. (HQ-DG000)" <kelly.e.fast@nasa.gov>, "Chodas, Paul W (JPL-4085)[Jet Propulsion Laboratory]" <paul.w.chodas@jpl.nasa.gov>, "Johnson, Alana R. (HQ-NG000)[InuTeq, LLC]" <alana.r.johnson@nasa.gov>, "EXTERNAL" (b)(6)
Subject: [EXTERNAL] Re: Unhappy about Washington Post story

See attached story from the Sydney (Australia) Morning Herald - perhaps where this thing started, media-wise? It quotes the two Australian astronomers - anybody know them? If so, it might be helpful to ask them to think before they speak (of nuclear explosions and such...). I don't know whether the Sydney reporter reached out to them or whether they reached out to him. All the rest - including WaPo - is simply repetition.

What this story says to me is that the detection and notification system worked perfectly, as usual. (For pete's sake, these stories used CNEOS's visuals!) If Alana reaches out, she might want to make this point.

This story also says to me that we have to keep up our good work of calming down asteroid rhetoric - city-killers, nukes, etc. I will reach out as well.

Paul, when you talk with NPR (is it Joe Palca?), I'm sure you'll make these points -- the system keeps working like it's supposed to, an asteroid can't be a "city killer" when it flies by Earth at 70,000 km, and if and when an asteroid impact might occur, it would not release any nuclear radiation. (Tim, no wonder you went ballistic when you saw this.... 😊)

Sigh...

Cheers,

(b)(6)

(b)(6) Ph.D.
Consultant to NASA's Astrobiology Program and Planetary Defense Coordination Office
National Institute of Aerospace

(b)(6)

On Fri, Jul 26, 2019 at 10:48 PM Johnson, Lindley (HQ-DG000) <lindley.johnson@nasa.gov> wrote:

As Kelly says, I think this is lazy journalism.

I dont recognize the name of the reporter. Not one of the usual WP science reporters.

I've copied Alana. Maybe NASA OCOMMS can suggest to WP "WTF, over".

Lindley

Lindley N Johnson
Planetary Defense Officer
HQ NASA

----- Original Message -----

From: "Fast, Kelly E. (HQ-DG000)" <kelly.e.fast@nasa.gov>
Date: Fri, July 26, 2019 9:11 PM -0400
To: "Chodas, Paul W (JPL-4085)[Jet Propulsion Laboratory]" <paul.w.chodas@jpl.nasa.gov>, "Johnson, Lindley (HQ-DG000)" <lindley.johnson@nasa.gov>
CC: "EXTERNAL- [REDACTED] (b)(6) [REDACTED] (b)(6) (HQ-DG000)
[NATIONAL INSTITUTE OF AEROSPACE]" [REDACTED] (b)(6)
Subject: Re: Unhappy about Washington Post story

Hi Paul,

I hadn't seen this one, but I saw these names in earlier articles elsewhere, so I think it's just the usual lazy journalism where reporters report on and follow up other reporter's reports. That's why the Washington Post is focusing on Australian scientists... they saw them in another article and didn't think about the fact that they're in Washington DC, and that NASA HQ is in Washington DC, hmmm....

Adding Linda here because she's great at being a third party and reminding reporters that it IS possible to reach directly out to NASA if they want the right information on what NASA is doing.

At least NPR reached out to you instead of Australia!

Have a nice weekend,
Kelly

Dr. Kelly Elizabeth Fast
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From: "Chodas, Paul W (US 4085)" <paul.w.chodas@jpl.nasa.gov>
Date: Friday, July 26, 2019 at 8:55 PM
To: Lindley Johnson <lindley.johnson@nasa.gov>, Kelly Fast <kelly.e.fast@nasa.gov>
Cc: [REDACTED] (b)(6)
Subject: Unhappy about Washington Post story

Lindley and Kelly,

As you probably already know, this article in the Washington Post is getting major coverage:
https://www.washingtonpost.com/nation/2019/07/26/it-snuck-up-us-city-killer-asteroid-just-missed-earth-scientists-almost-didnt-detect-it-time/?utm_term=.2a6a298e3707

I find it disheartening that the scientists quoted therein have very little to do with asteroids, and yet the article makes them out as playing a major role in the story and seems to focus on how they felt and what they think needs to be done. They do provide lip service to "NASA" and provide links, but very few will follow those. Why on Earth wouldn't the reporter seek out comments from true experts like you guys at PDCO or observers at e.g. ATLAS, or maybe us at CNEOS whose web site the scientist clearly used?

OK, I'm just venting to you guys, but it is frustrating. Somehow NASA is not seen as the automatic go-to source for questions in stories like this.

By the way NPR contacted me, and I spoke with them this morning. I'll be interviewed on Monday, but interest in this story will be negligible by then.

Have a great weekend!

Paul

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Subject: Re: [EXTERNAL] Re: 2019 OK
Date: Saturday, July 27, 2019 at 3:25:00 AM Pacific Daylight Time
From: (b)(6)
To: Chodas, Paul W (US 4085)
CC: (b)(6) Farnocchia, Davide (US 392R), Johnson, Lindley (HQ-DG000), EXTERNAL-Fast, Kelly (US 9300-NASA), (b)(6) Chesley, Steven R (US 392R), (b)(6)
Attachments: image001.png, image002.png, image003.png, image004.png, image005.png, image006.png, image007.png, image008.png, image009.png, image010.png, image011.png, image012.png

Hi Paul:

July 22 - high humidity all night

July 23 - heavy cirrus all night

July 24 - we didn't look in the right place.

The Moon is probably the real culprit. But the Moon is there every month, so things can sneak through. We probably would need about twice as many Pan-STARRS/CSS sized assets as we presently have to cast a good net across the sky to catch objects like this early. Weather and the Moon bot make it hard.

(b)(6)

On Fri, Jul 26, 2019 at 8:16 PM Chodas, Paul W (US 4085) <paul.w.chodas@jpl.nasa.gov> wrote:

Hi (b)(6)

Thank you for this very complete report.

Putting all the comments together, I'm finally seeing a clearer picture, which I'll try to summarize. This object slipped through a whole series of our capture nets, for a bunch of different reasons:

- in late June it was simply too faint for automated detection by anyone.
- In the July 7-8 timeframe it became bright enough to be detected but was still moving too slowly to be automatically identified as an NEA.
- In the July 19 timeframe it started to move fast enough to be identified as an NEA by G96 and PS1 but it was then too close to the (nearly full) Moon
- It emerged from Moon avoidance period around July 21, but CSS was already shut down because of weather.

- ATLAS did pick it up on July 21 but it was still moving too slowly to be identified as an NEA by the ATLAS filters.

So that just leaves the final few days, and I presume Pan-STARRS was just not looking in the right direction during that time?

So, was this just a particularly sneaky asteroid? I wonder how many times this situation has happened without the asteroid being discovered at all.

Thanks,

Paul

Dr. Paul W. Chodas

Manager, Center for Near Earth Object Studies

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(b)(6)

From: (b)(6)

Date: Friday, July 26, 2019 at 7:45 PM

To: (b)(6)

Cc: "Chodas, Paul W (US 4085)" <paul.w.chodas@jpl.nasa.gov>, (b)(6)
(b)(6) "Farnocchia, Davide (US 392R)" <davide.farnocchia@jpl.nasa.gov>,
"Johnson, Lindley (HQ-DG000)" <lindley.johnson@nasa.gov>, "EXTERNAL-Fast, Kelly (US 9300-
NASA)" <Kelly.E.Fast@nasa.gov>, (b)(6) "Chesley, Steven R (US 392R)"
<steve.chesley@jpl.nasa.gov>, (b)(6)
Subject: Re: [EXTERNAL] Re: 2019 OK

Hi Paul:

I forgot to include one additional comment on 2019 OK:

Increased exposure time would have made this easier for us to detect. We presently use 45 seconds. If we had been using 90 seconds for example, we may have found it using our normal processing. The longer exposure would lead to more movement between images, and fainter detections. But this would be at the expense of reduced sky coverage. And long sequences run higher risk from being interrupted by weather.

Our quads usually have about 18-20 footprints. They take about 70 minutes to complete. Doubling the exposure time, while maintaining the same number of footprints would take an additional 72*45 seconds, or about 55 minutes. So a "chunk" would take a little over 2 hours. That is almost twice as long as what we are presently using. And sky coverage would be cut by almost half.

(b)(6)

On Fri, Jul 26, 2019 at 4:24 PM (b)(6) wrote:

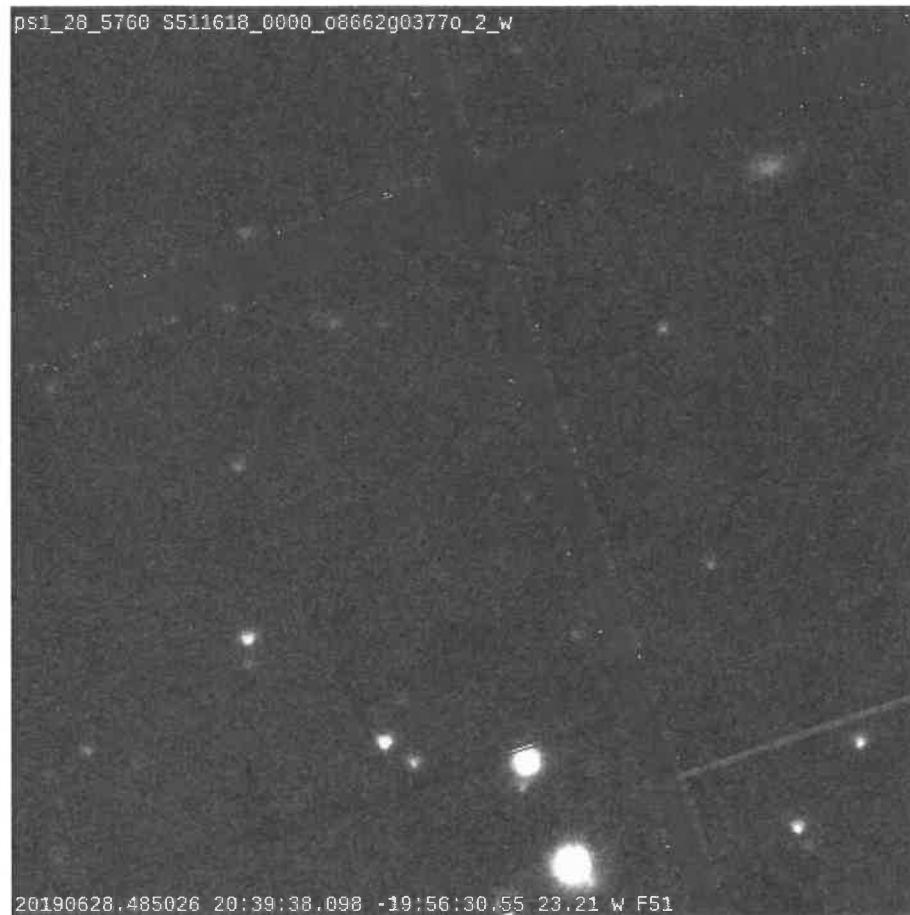
Hi Paul:

Pan-STARRS saw 2019 OK twice. Astrometry is attached.

On June 28, it was very faint. The images are attached. It is too faint for our automated source detection software to find it. If you look at the attached postage stamp images (there are 8 - the object fell in an overlap region, so was seen in two adjacent quads), you will see pattern noise which is present in our camera. Once you know where a faint object like this is in an image you can find it. But it is very difficult to find things as faint as this with the noise we have in the camera in software without triggering an intractable number of false positives. The dark streaks in the images are persistence burns caused by bright objects in the previous exposures.

I think that if we were able to upgrade our CCDs to the e2V 9k or similar CCDs in the future, then detection of faint sources like this would become possible. These CCDs have higher QE and less noise than the MITLL CCDs presently being used in the PS1 camera. Burns are not present in the PS2 camera.

On June 28, the rate of motion was 0.07 degrees per day. Digest score was 87.





20190628.486963 20:39:38.153 -19:56:30.50 23.87 W F51

ps1_28_5760 S511618_0000_08662g03920_2_W



20190628.494734 20:39:38.257 -19:56:29.66 22.96 W F51

ps1_28_4308 S511618_0000_08662g03950_1_W

20190628.496667 20:39:38.309 -19:56:29.60 23.09 W F51

ps1_28_5760 S511618_0000_08662g04070_2_W

20190628.504436 20:39:38.463 -19:56:29.18 22.49 W F51

ps1_28_4308 S511618_0000_08662g04100_1_W

20190628.506372 20:39:38.465 -19:56:29.05 23.22 W F51

ps1_28_5760 S511618_0000_08662g04220_2_W



On July 7, the object is brighter, but its motion was very slow, only 0.01 degrees per day. This failed our difference processing, because it was effectively self-subtracted.

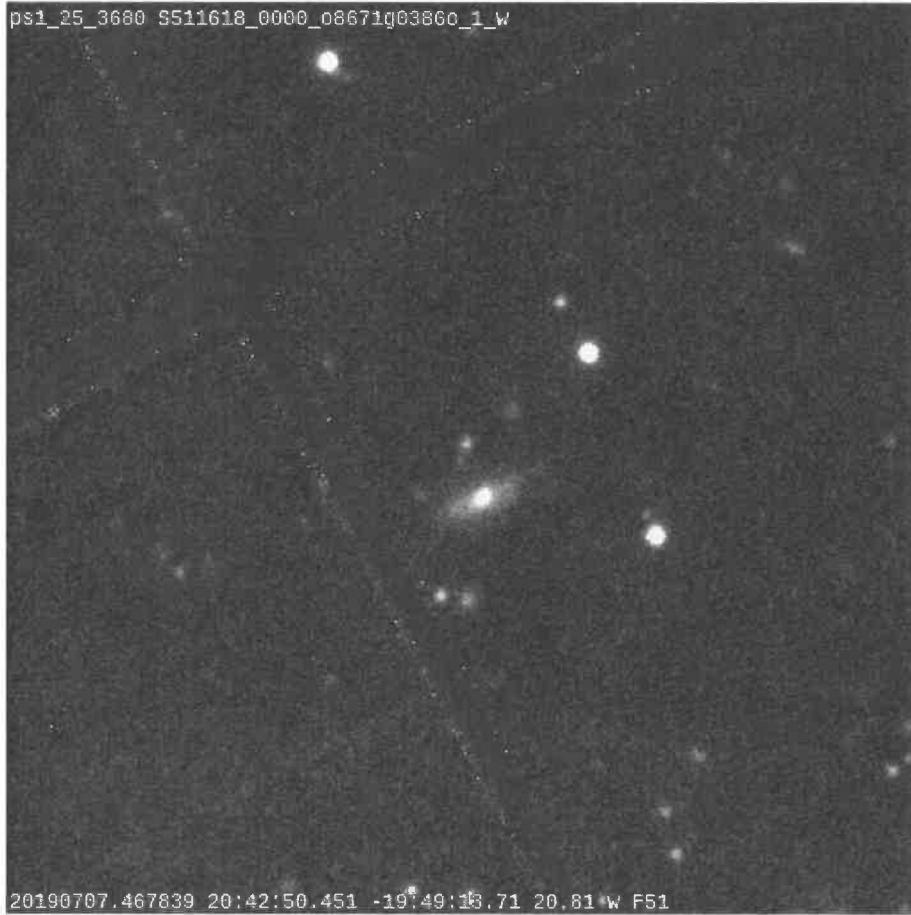
Digest score was 99.

We can see the object in our warp-stack processing, but this is still in experimental mode. Warp-stack processing is done by warping an image onto a sky plane, then subtracting a (low-noise) stacked image made from many exposures. We are not yet routinely searching for NEOs in the warp-stack processing because this process still produces too many false detections - it is still experimental.

I expect that the object would have been detected via source detection techniques, which we are also experimenting with, but these are not close to production level at this time.

The (slow) motion is to the east, which is opposite to the direction that an outer solar system object would move. So in this case, there is no ambiguity - a slow moving object moving to the east at opposition is very suspicious (other than an NEO, it can also be a more distant object in a retrograde orbit such as a comet).

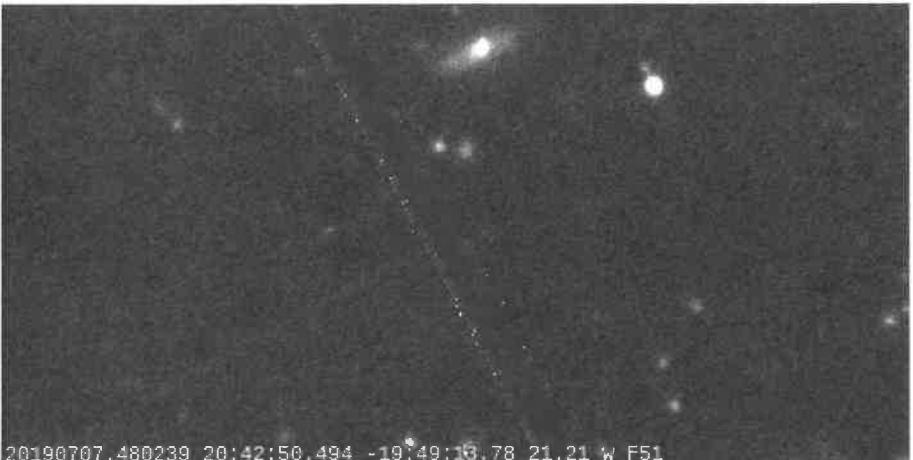
ps1_25_3680 S511618_0000_08671g03860_1_W



20190707.467839 20:42:50.451 -19:49:13.71 20.81°W F51

ps1_25_3680 S511618_0000_08671g04050_1_W





20190707.480239 20:42:50.494 -19°49:13.78 21.21 W F51

ps1_25_3680 S511618_0000_08671g04240_1_W



20190707.492639 20:42:50.525 -19°49:13.63 21.73 W F51



In the subsequent period, the moon became bright. And the object's motion may have entered a period during which the digest score became low (see the (b)(6) (b)(6) paper). The object was very close to the Moon on July 18. It was in our Moon avoidance zone roughly from July 14-21. We had some weather issues in the second half of the night on July 11 and 12.

I hope this is helpful.

(b)(6)

K19000K	C2019 06 28.48696320	39 38.147-19 56 30.33	22.9	GVE0056F51
K19000K	C2019 06 28.49473420	39 38.257-19 56 29.69	22.7	GVE0056F51
K19000K	C2019 06 28.49666720	39 38.312-19 56 29.55	22.7	GVE0056F51

K19000K	C2019	06	28.50443620	39	38.462-19	56	29.22	22.2	GVE0056F51
K19000K	C2019	06	28.50637220	39	38.464-19	56	29.05	22.9	GVE0056F51
K19000K	C2019	06	28.51608020	39	38.628-19	56	28.52	22.6	GVE0056F51
K19000K	C2019	07	07.46783920	42	50.466-19	49	13.96	21.2	GVE0056F51
K19000K	C2019	07	07.48023920	42	50.498-19	49	13.85	21.2	GVE0056F51
K19000K	C2019	07	07.49263920	42	50.520-19	49	13.54	21.2	GVE0056F51
K19000K	C2019	07	07.50505120	42	50.547-19	49	13.23	21.3	GVE0056F51

On Fri, Jul 26, 2019 at 10:36 AM (b)(6) wrote:

Hi Paul,

Removing the moon and bad weather, this object would have become visible to G96 starting around July 8, but too slow to detect until about July 19 (on July 8 it was moving slower than TNO rates at transit!). It would have been visible to 703 starting July 15, but too slow to detect until July 22, a few days before flyby.

I can't recall any similar cases where an NEO was bright enough for easy detection, but too slow to detect for most of its apparition.

(b)(6)

(b)(6)

On Jul 26, 2019, at 12:05 PM, Chodas, Paul W (US 4085) <paul.w.chodas@jpl.nasa.gov> wrote:

Good point (b)(6) but I suspect that background like this will only partially alleviate concerns that a relatively large one was "missed".

Question: if it weren't for bad weather and lunar interference, would this one have slipped past the CSS filters as well?

Thanks,

Paul

Dr. Paul W. Chodas

Manager, Center for Near Earth Object Studies

Jet Propulsion Laboratory

(b)(6)

4800 Oak Grove Drive

Pasadena, CA 91109-8099

(818) 354-7795 Office

(b)(6)

From: (b)(6)

Date: Friday, July 26, 2019 at 11:57 AM

To: "Chodas, Paul W (US 4085)" <paul.w.chodas@jpl.nasa.gov>

Cc: (b)(6) "Farnocchia, Davide (US 392R)"

<davide.farnocchia@jpl.nasa.gov>, (b)(6)

"Johnson, Lindley (HQ-DG000)" <Lindley.johnson@nasa.gov>, "EXTERNAL-Fast, Kelly (US 9300-NASA)" <Kelly.E.Fast@nasa.gov>, (b)(6)

(b)(6) "Chesley, Steven R (US 392R)" <steve.chesley@jpl.nasa.gov>
Subject: Re: [EXTERNAL] Re: 2019 OK

Hi Paul,

It may also be worth mentioning the slew of other earth-approaching (~lunar distance) objects that were detected by NASA-funded surveys in the last few weeks, to put this single “miss” in context.

(b)(6)

(b)(6)

On Jul 26, 2019, at 11:54 AM, Chodas, Paul W (US 4085)
<paul.w.chodas@jpl.nasa.gov> wrote:

Thanks, (b)(6) So, if I get asked about this, I would pass along your sentiment, that this case proved useful for refining operating boundaries at NASA surveys so that NEAs like this one can be identified earlier.

In this case, ATLAS could have given an “alert” 3 days earlier than we actually got, which is obviously very significant.

Paul

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Manager, Center for Near Earth Object Studies

Jet Propulsion Laboratory

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(b)(6)

From: (b)(6)

Date: Friday, July 26, 2019 at 11:21 AM

To: "Chodas, Paul W (US 4085)" <paul.w.chodas@jpl.nasa.gov>

Cc: "Farnocchia, Davide (US 392R)" <davide.farnocchia@jpl.nasa.gov>,

(b)(6) (b)(6) "Johnson, Lindley (HQ-DG000)"
<Lindley.johnson@nasa.gov>, "EXTERNAL-Fast, Kelly (US 9300-NASA)"
<Kelly.E.Fast@nasa.gov>, (b)(6)
"Chesley, Steven R (US 392R)" <steve.chesley@jpl.nasa.gov>

Subject: Re: [EXTERNAL] Re: 2019 OK

Hi Paul,

That sounds about right. It's not a very satisfying answer because we know we can do better. But these cases help us push our operating boundaries even wider so that there will be fewer of these in the future.

(b)(6)

On Fri, Jul 26, 2019 at 8:14 AM Chodas, Paul W (US 4085) <paul.w.chodas@jpl.nasa.gov> wrote:

Thanks, (b)(6) So, in contrast to the Chelyabinsk line of "it came in too close to the Sun to be observed", we have here a converse situation:

"It came in from too close to the opposition point [to be identified quickly as an NEO]."

This was a sneaky one on many fronts (full moon, monsoon season, high v_infinity, very near the opposition point).

Paul

Dr. Paul W. Chodas

Manager, Center for Near Earth Object Studies

Jet Propulsion Laboratory

(b)(6)

4800 Oak Grove Drive

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(b)(6)

From: (b)(6)
Date: Friday, July 26, 2019 at 10:49 AM
To: "Farnocchia, Davide (US 392R)"
<davide.farnocchia@jpl.nasa.gov>
Cc: "Chodas, Paul W (US 4085)" <paul.w.chodas@jpl.nasa.gov> (b)(6)
(b)(6)
(b)(6) "Johnson, Lindley (HQ-DG000)"
<Lindley.Johnson@nasa.gov>, "EXTERNAL-Fast, Kelly (US 9300-
NASA)" <Kelly.E.Fast@nasa.gov>, (b)(6)
(b)(6) "Chesley, Steven R (US 392R)"
<steve.chesley@jpl.nasa.gov>
Subject: Re: [EXTERNAL] Re: 2019 OK

Hi Davide,

A10f1QW had digest2 = 97. Using high digest2 as an acceptance criterion doesn't help too much because nearly everything unknown and moving slowly will already have a high digest2. The main consideration for us in this case is separation of slow-moving NEOs from slightly jittering variable stars, which all go into the "unknown, slow-moving, might-be-an-NEO" pool. Our pixels are big so at our cadence we have more confusion in this regime than PS1 or G96.

(b)(6)

On Fri, Jul 26, 2019 at 7:30 AM Farnocchia, Davide (US 392R) <davide.farnocchia@jpl.nasa.gov> wrote:

(b)(6)

Just curious, what is the digest score for that tracklet?

If higher than 65, would it make sense to directly use the digest score for your screening cuts?

Davide

Sent from my iPhone

On Jul 26, 2019, at 7:19 PM, (b)(6) (b)(6) wrote:

Hi Paul,

We have had some weather, but it's not to blame. ATLAS observed it as part of routine operations on July 21 -- we even had an automatic tracklet for it -- but as is typical of these close approachers, it was moving very slowly against the background and the tracklet just missed our screening cuts. Once it hit the NEOCP it was an easy find.

We have since opened up our minimum velocity cut a bit, from 0.1 deg/day to 0.025 deg/day, which should match our sensitivity better.

(b)(6)

On Fri, Jul 26, 2019 at 7:10 AM Chodas, Paul W (US 4085) <paul.w.chodas@jpl.nasa.gov> wrote:

(b)(6)

There is some media interest today in 2019 OK, which passed at 0.2 LD yesterday, so I'm motivated to seek out an answer to a question I'm sure we'll be asked. Namely, why was 2019 OK not discovered by one of the major NASA surveys? Why was it not discovered until an ~11-inch telescope (SONEAR) found it at magnitude 15?

(b)(6) pointed out earlier this week that "this object has been hanging around near opposition for several weeks, clear of the Milky Way. It's been brighter than V~21.5 for about two weeks, and brighter than V~20 for about a week. The moon was in the way for much of that time..."

So, yes, this object came in at a bad time within the lunation, but are there other reasons that all the major surveys missed discovering it? Can we just put it down to bad weather?

Bottom line: If SONEAR hadn't found this object, is it possible it could have escaped discovery completely?

Thanks,

Paul

Dr. Paul W. Chodas

Manager, Center for Near Earth Object Studies

Jet Propulsion Laboratory

(b)(6)

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(b)(6)

Subject: Re: Unhappy about Washington Post story
Date: Sunday, July 28, 2019 at 11:35:37 PM Pacific Daylight Time
From: Chodas, Paul W (US 4085)
To: Johnson, Lindley (HQ-DG000), Johnson, Alana R. (HQ-NG000)[InuTeq, LLC], EXTERNAL-Fast, Kelly (US 9300-NASA)
CC: EXTERNAL- [REDACTED] (b)(6) [REDACTED] (b)(6) (HQ-DG000)[NATIONAL INSTITUTE OF AEROSPACE]

Thanks, Alana., these are appropriate responses.

Just to be clear, since the subject line is mne, I wasn't unhappy that there was a story about 2019 OK, or even about the facts quoted in the story, I was just disappointed that a paper like the WashPost didn't even bother to contact the primary sources available right at NASA HQ in DC, or contact us here at JPL/CNEOS, either of whom could have provided background and context on a fairly rare and important event like this one.

By my very quick calculation, and event like this (an asteroid this size passing this close to Earth) happens about once every 70-80 years or so. An actual impact from an asteroid of this size is of course even rarer: something like once every 5000 years or so.

Best,
Paul

Dr. Paul W. Chodas
Manager, Center for Near Earth Object Studies
Jet Propulsion Laboratory
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4800 Oak Grove Drive
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(b)(6)

From: "Johnson, Lindley (HQ-DG000)" <lindley.johnson@nasa.gov>
Date: Sunday, July 28, 2019 at 7:02 PM
To: "Johnson, Alana R. (HQ-NG000)[InuTeq, LLC]" <alana.r.johnson@nasa.gov>, "EXTERNAL-Fast, Kelly (US 9300-NASA)" <Kelly.E.Fast@nasa.gov>, "Chodas, Paul W (US 4085)" <paul.w.chodas@jpl.nasa.gov>
Cc: "EXTERNAL" [REDACTED] (b)(6) [REDACTED] (b)(6)
(b)(6)
Subject: Re: Unhappy about Washington Post story

That'd be great. Thanks, Alana!

Lindley

Lindley N Johnson
Planetary Defense Officer
HQ NASA

----- Original Message -----

From: "Johnson, Alana R. (HQ-NG000)[InuTeq, LLC]" <alana.r.johnson@nasa.gov>
Date: Sun, July 28, 2019 8:53 PM -0500
To: "Johnson, Lindley (HQ-DG000)" <lindley.johnson@nasa.gov>, "Fast, Kelly E. (HQ-DG000)" <kelly.e.fast@nasa.gov>, "Chodas, Paul W (JPL-4085)[Jet Propulsion Laboratory]" <paul.w.chodas@jpl.nasa.gov>
CC: "EXTERNAL-[REDACTED]" (b)(6) ' (b)(6) (HQ-DG000)
[NATIONAL INSTITUTE OF AEROSPACE]" (b)(6)
Subject: Re: Unhappy about Washington Post story

Good evening.

The article is shoddy, especially with NASA HQ right here in DC. That said, at least comments by Emily Lakdawalla at Planetary Society offered some balance.

I have nothing in my email by way of a request from this writer. I will contact her tomorrow and try to familiarize her with PDCO and CNEOS. This is an opportunity to educate her, and WaPo readers, about our efforts, and maybe go for a larger story in the WashPost.

Vr,
Alana

Alana R. Johnson
Senior Communications Specialist
Planetary Science Division
National Aeronautics and Space Administration
Headquarters Washington, D.C.
alana.r.johnson@nasa.gov
Cell: (b)(6)

On: 26 July 2019 22:48, "Johnson, Lindley (HQ-DG000)" <lindley.johnson@nasa.gov> wrote:

As Kelly says, I think this is lazy journalism.

I dont recognize the name of the reporter. Not one of the usual WP science reporters.

I've copied Alana. Maybe NASA OCOMMS can suggest to WP "WTF, over".

Lindley

Lindley N Johnson
Planetary Defense Officer
HQ NASA

----- Original Message -----

From: "Fast, Kelly E. (HQ-DG000)" <kelly.e.fast@nasa.gov>
Date: Fri, July 26, 2019 9:11 PM -0400
To: "Chodas, Paul W (JPL-4085)[Jet Propulsion Laboratory]" <paul.w.chodas@jpl.nasa.gov>, "Johnson, Lindley (HQ-DG000)" <lindley.johnson@nasa.gov>
CC: "EXTERNAL- [REDACTED] (b)(6) [REDACTED] (b)(6) (HQ-DG000)[NATIONAL INSTITUTE OF AEROSPACE]" <billingslinda1@gmail.com>
Subject: Re: Unhappy about Washington Post story

Hi Paul,

I hadn't seen this one, but I saw these names in earlier articles elsewhere, so I think it's just the usual lazy journalism where reporters report on and follow up other reporter's reports. That's why the Washington Post is focusing on Australian scientists... they saw them in another article and didn't think about the fact that they're in Washington DC, and that NASA HQ is in Washington DC, hmmm....

Adding (b)(6) here because she's great at being a third party and reminding reporters that it IS possible to reach directly out to NASA if they want the right information on what NASA is doing.

At least NPR reached out to you instead of Australia!

Have a nice weekend,
Kelly

Dr. Kelly Elizabeth Fast
Near-Earth Object Observations Program Manager
Planetary Defense Coordination Office
Planetary Science Division
NASA Headquarters
(202) 358-0768

From: "Chodas, Paul W (US 4085)" <paul.w.chodas@jpl.nasa.gov>
Date: Friday, July 26, 2019 at 8:55 PM
To: Lindley Johnson <lindley.johnson@nasa.gov>, Kelly Fast <kelly.e.fast@nasa.gov>
Cc: [REDACTED] (b)(6) [REDACTED]
Subject: Unhappy about Washington Post story

Lindley and Kelly,

As you probably already know, this article in the Washington Post is getting major coverage:

https://www.washingtonpost.com/nation/2019/07/26/it-snuck-up-us-city-killer-asteroid-just-missed-earth-scientists-almost-didnt-detect-it-time/?utm_term=.2a6a298e3707

I find it disheartening that the scientists quoted therein have very little to do with asteroids, and yet the article makes them out as playing a major role in the story and seems to focus on how they felt and what they think needs to be done. They do provide lip service to "NASA" and provide links, but very few will follow those. Why on Earth wouldn't the reporter seek out comments from true experts like you guys at PDCO or observers at e.g. ATLAS, or maybe us at CNEOS whose web site the scientist clearly used?

OK, I'm just venting to you guys, but it is frustrating. Somehow NASA is not seen as the automatic go-to source for questions in stories like this.

By the way NPR contacted me, and I spoke with them this morning. I'll be interviewed on Monday, but interest in this story will be negligible by then.

Have a great weekend!

Paul

Dr. Paul W. Chodas
Manager, Center for Near Earth Object Studies
Jet Propulsion Laboratory

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4800 Oak Grove Drive
Pasadena, CA 91109-8099
(818) 354-7795 Office

(b)(6)

Subject: FW: Asteroid notifications and characterization
Date: Monday, July 29, 2019 at 1:59:05 PM Pacific Daylight Time
From: Johnson, Alana R. (HQ-NG000)[InuTeq, LLC]
To: Johnson, Lindley (HQ-DG000), EXTERNAL-Fast, Kelly (US 9300-NASA), Chodas, Paul W (US 4085), Billings, Linda (HQ-DG000)[NATIONAL INSTITUTE OF AEROSPACE]
Attachments: image001.png, image002.png

FYSA – what I sent to WaPo.

Alana R. Johnson
Senior Communications Specialist
Planetary Science Division
National Aeronautics and Space Administration
Headquarters Washington, D.C.
alana.r.johnson@nasa.gov
O: 202-358-1501
C: (b)(6)



From: "Johnson, Alana R. (HQ-NG000)[InuTeq, LLC]" <alana.r.johnson@nasa.gov>
Date: Monday, July 29, 2019 at 4:11 PM
To: (b)(6) (b)(6)
Cc: "Hautaluoma, Grey (HQ-NI000)" <grey.hautaluoma-1@nasa.gov>
Subject: Asteroid notifications and characterization

Hello, Allyson.

Your recent article, published June 26, '*It snuck up on us*': *Scientists stunned by 'city-killer' asteroid that just missed Earth*, was an opportunity to inform your readers of the important work being done by NASA's Planetary Defense Coordination Office. Unfortunately, that opportunity was missed.

Your article contained hyperlinks to the Center for Near Earth Object Studies (CNEOS) and other NASA Planetary Defense pages, yet none of our scientists were contacted as expert sources.

We would like to offer details in an effort to more accurately characterize the close approach to the Earth by this near-Earth object (NEO). Additionally, I would be happy to arrange an interview for you with our Planetary Defense Coordination Office or the director of CNEOS.

The detection and notification system worked, in compliance with NASA Policy Directive (NPD) 8740.1 - *Notification and Communications Regarding Potential Near-Earth Object Threats*, showing the object would not present an impact hazard. 2019 OK safely passed Earth at a distance from its surface of about 45,000 miles (74,000 kilometers), approximately 1/5th the distance from the Earth to the Moon, at 9:22 pm EDT on Wednesday, July 24, 2019.

Although small asteroids come between Earth and Moon almost weekly, this object is estimated at between 180 and 430 feet (50 and 130 meters) in size.

Asteroid 2019 OK was originally discovered in the evening of July 23rd by SONEAR (Southern Observatory for Near-Earth Asteroids Research), a Brazilian team of asteroid observers, about 24 hours before closest approach. Once follow up observations were obtained by other observatories that evening, “precovery” observations were obtained by the NASA-funded Pan-STARRS and ATLAS observatories as far back as June 28. This allowed scientists to refine the orbit and confirm the very close approach on the evening of July 24th. This is the closest approach known by an object this size in the last century, and the closest predicted until the close approach of Apophis in April 2029.

Detection of 2019 OK was complicated by the fact that it is on a highly elliptical orbit and appeared to not be moving on the plane of sky because of the geometry of the orbit relative to Earth for much of the month prior to the close approach; the complication of a very dim object in a crowded field of stars and the lack of motion made it much harder to detect and calculate an orbit until it was quite close.

2019 OK is now inbound to perihelion and will then travel on its orbit to beyond the orbit of Mars before turning back toward the Sun. It will not pass close by Earth again until the next century, and no additional passes within the Moon’s orbit are currently predicted.

Further information about 2019 OK can be found on the JPL Center for Near-Earth Object Studies (CNEOS) webpage at <https://ssd.jpl.nasa.gov/sbdb.cgi?sstr=2019%20OK1>. For additional information about NASA’s Planetary Defense Coordination Office: www.nasa.gov/planetarydefense.

NASA’s Planetary Science Division is dedicated to studying the science and technologies that can best protect Earth. We appreciate you bringing attention to the topic and look forward to working with you on future articles.

Best regards,
Alana

Alana R. Johnson
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Planetary Science Division
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Headquarters Washington, D.C.
alana.r.johnson@nasa.gov
O: 202-358-1501
C: (b)(6)



Subject: FW: Asteroid 2019 OK -- NASA Planetary Defense Coordination Office
Date: Monday, July 29, 2019 at 1:59:55 PM Pacific Daylight Time
From: Johnson, Alana R. (HQ-NG000)[InuTeq, LLC]
To: Johnson, Lindley (HQ-DG000), EXTERNAL-Fast, Kelly (US 9300-NASA), Chodas, Paul W (US 4085), Billings, Linda (HQ-DG000)[NATIONAL INSTITUTE OF AEROSPACE]
Attachments: image001.png, image002.png

FYSA – Sent to The Hill

Alana R. Johnson
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O: 202-358-1501
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From: "Johnson, Alana R. (HQ-NG000)[InuTeq, LLC]" <alana.r.johnson@nasa.gov>
Date: Monday, July 29, 2019 at 4:24 PM
To: (b)(6) (b)(6)
Cc: "Hautaluoma, Grey (HQ-NI000)" <grey.hautaluoma-1@nasa.gov>
Subject: Asteroid 2019 OK -- NASA Planetary Defense Coordination Office

Hello, Brooke.

Your recent article, published June 26, '*City-killer*' asteroid just misses earth, shocks scientists, was an opportunity to inform your considerable audience about the important work being done by NASA's Planetary Defense Coordination Office. Unfortunately, that opportunity was missed.

We would like to offer details in an effort to more accurately characterize the close approach to the Earth by this near-Earth object (NEO). Additionally, I would be happy to arrange an interview for you with our Planetary Defense Coordination Office or the director of CNEOS.

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about 24 hours before closest approach. Once follow up observations were obtained by other observatories that evening, “precovery” observations were obtained by the NASA-funded Pan-STARRS and ATLAS observatories as far back as June 28. This allowed scientists to refine the orbit and confirm the very close approach on the evening of July 24th. This is the closest approach known by an object this size in the last century, and the closest predicted until the close approach of Apophis in April 2029.

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Further information about 2019 OK can be found on the JPL Center for Near-Earth Object Studies (CNEOS) webpage at https://ssd.jpl.nasa.gov/sbdb.cgi?sstr=2019_OK1. For additional information about NASA’s Planetary Defense Coordination Office: www.nasa.gov/planetarydefense.

NASA’s Planetary Science Division is dedicated to studying the science and technologies that can best protect Earth. We appreciate you bringing attention to the topic and look forward to working with you on future articles.

Best regards,
Alana

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